C
2
732
c.1972

WATER RESOURCES REVIEW for DECEMBER 1972

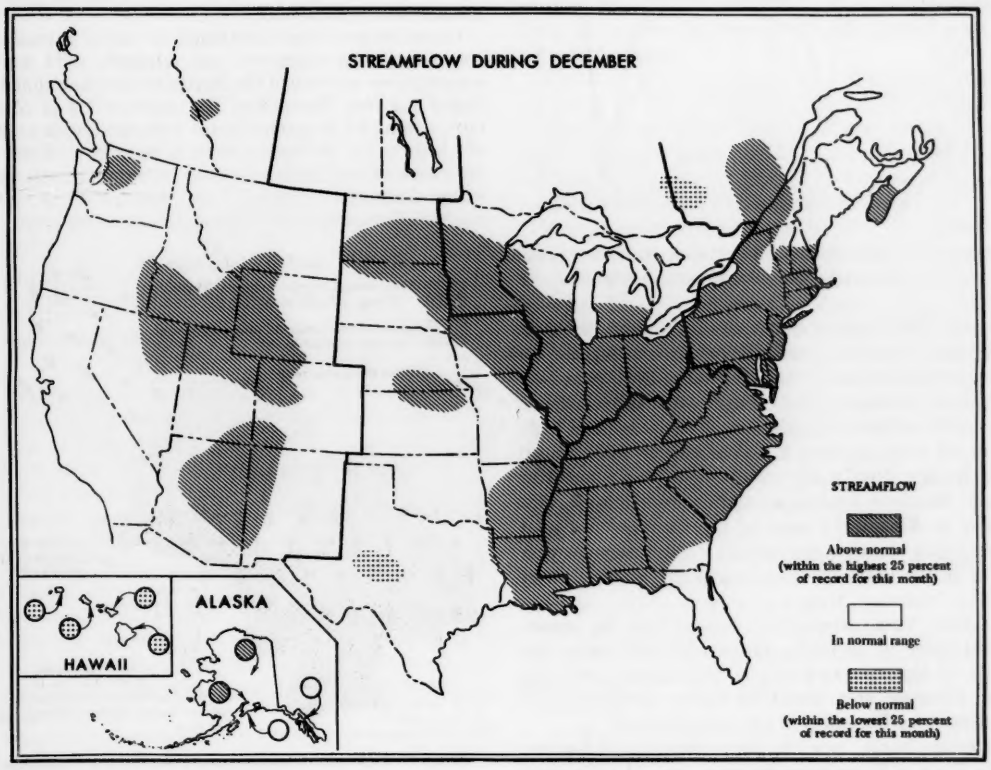
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

CANADA
DEPARTMENT OF THE ENVIRONMENT
WATER RESOURCES BRANCH

STREAMFLOW AND GROUND-WATER CONDITIONS

Streamflow generally increased in eastern and western parts of conterminous United States, and decreased in northern and central States, in Alaska and Hawaii, and in southern Canada. Some flooding occurred in Tennessee, Virginia, West Virginia, and Idaho.

Large areas of above-normal streamflow persisted in the eastern and west-central sections of the United States. Flows also were above normal in smaller areas in the Provinces of Nova Scotia, Quebec, and Alberta, and in Kansas, Nebraska, and Washington. Below-normal streamflow continued in small areas of Texas and Quebec. Monthly mean discharge of Mississippi River near Vicksburg, Mississippi, representing runoff from about 40 percent of conterminous United States, was highest of record for December, as was the discharge of many smaller index streams in eleven States.



CONTENTS OF THIS ISSUE: Northeast, Southeast, Western Great Lakes region, Midcontinent, West; Usable contents of selected reservoirs near end of December 1972; Flow of large rivers during December 1972; Alaska, Hawaii; Availability of water in Kalamazoo County, southwestern Michigan.

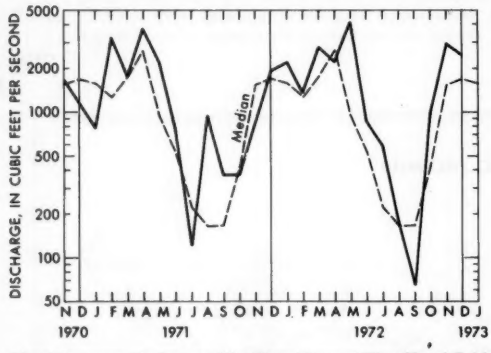
87

NORTHEAST

[Atlantic Provinces and Quebec; Delaware, Maryland, New York, New Jersey, Pennsylvania, and the New England States]

STREAMFLOW INCREASED IN MOST BASINS OF THE SOUTHERN PART OF THE REGION AND REMAINED ABOVE THE NORMAL RANGE, BUT DECREASED IN THE NORTHERN PROVINCES AND STATES WHERE ABOVE-NORMAL FLOWS OCCURRED IN PARTS OF NOVA SCOTIA, QUEBEC, MAINE, NEW HAMPSHIRE, AND VERMONT.

In Nova Scotia, streamflow decreased seasonally but remained above the normal range in the Northeast Margaree River and La Have River basins for the third consecutive month. Monthly mean discharge of La Have River at West Northfield has varied from 239 percent of median in October to 148 percent of median during December, and cumulative runoff for the first quarter of the 1973 water year was 72 percent greater than the median for that period (see graph).



Monthly mean discharge of La Have River at West Northfield, Nova Scotia (Drainage area, 484 square miles.)

In the New England States, monthly mean discharge of Branch River at Forestdale, R.I., was highest for December in 32 years, that of Wading River near Norton, Mass., was second highest in 47 years of record, and that of Ware River at Coldbrook, Mass., was third highest in 44 years of record. Calendar year 1972 runoff from Wading River basin near Norton, Mass., and West Branch Westfield River basin at Huntington, Mass., was highest in 47 and 37 years of record, respectively, at those gaging stations, and second highest calendar year runoff in 44 years of record occurred in Ware River basin at Coldbrook, Mass.

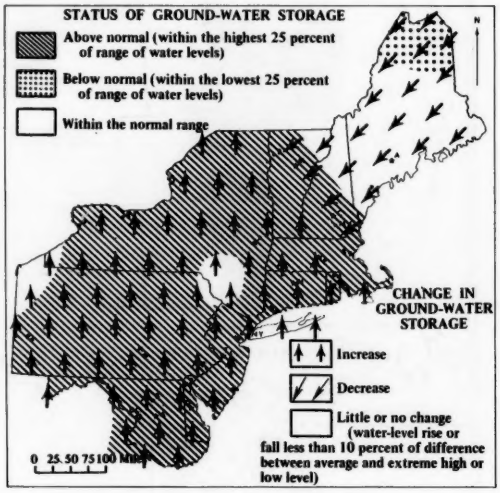
In New York, streamflow remained in the above-normal range at all index stations. Monthly mean discharge of Massapequa Creek at Massapequa, on Long Island (drainage area, about 38 square miles) was 17.8 cfs, highest for December in 34 years of record.

In Pennsylvania, monthly mean discharge of Susquehanna River at Harrisburg (drainage area, 24,100 square miles) was 96,700 cfs, highest for December in 82 years of record. In the northwestern corner of the State, flow of Oil Creek at Rouseville increased seasonally and remained above normal for the third consecutive month.

In New Jersey, Connecticut, and Maryland, streamflow was roughly two, three, and four times the December medians, respectively, throughout those States. The monthly mean discharges of 226 cfs on Great Egg Harbor River at Folsom, in southern New Jersey, and 300 cfs on South Branch Raritan River near High Bridge, in the north, were highest for December at those gaging stations since records began in 1925 and 1918, respectively. Similarly, in Connecticut, monthly mean discharges of 18.5 cfs, 158 cfs, 334 cfs, and 633 cfs, on Burlington Brook near Burlington, Mount Hope River near Warrenville, Pomperaug River at Southbury, and Salmon River near East Hampton, were highest for December in records that began, respectively, in 1931, 1940, 1932, and 1928. In the Maryland–District of Columbia area, monthly mean discharges of Seneca Creek at Dawsonville, Md., 272 cfs, Choptank River near Greensboro, Md., 485 cfs, and Potomac River near Washington, D.C., 35,900 cfs, were highest for December in records that began in 1930, 1948, and 1930, respectively.

Reservoir storage in the region was generally near or slightly above normal for December. The largest increase occurred in the six reservoirs of the Province of Nova Scotia, where the combined contents were 16 percent greater than in November.

Ground-water levels continued to rise as a result of above-normal precipitation and relatively mild winter temperatures in most of the Northeast; levels declined in Maine and New Hampshire. The continuation of conditions conducive to ground-water recharge caused unusually high end-of-December levels in parts of all States of the region except Maine. However, monthend levels were within the normal range on Long Island, N.Y., in northern New Hampshire, and in much of Maine (see map).


STATUS OF GROUND-WATER STORAGE
Above normal (within the highest 25 percent of range of water levels)
Below normal (within the lowest 25 percent of range of water levels)
Within the normal range
N
CHANGE IN GROUND-WATER STORAGE
Increase
Decrease
Little or no change (water-level rise or fall less than 10 percent of difference between average and extreme high or low level)
0 25 50 75 100 Miles

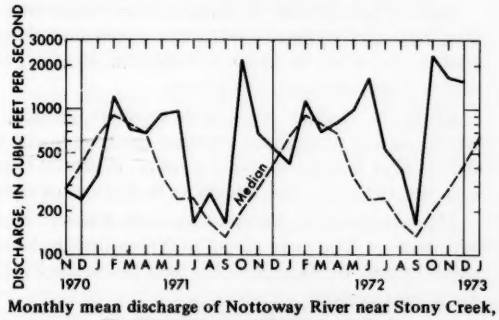
Map above shows ground-water storage near end of December and change in ground-water storage from end of November to end of December.

SOUTHEAST

[Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia]

STREAMFLOW INCREASED THROUGHOUT THE REGION EXCEPT IN VIRGINIA. ABOVE-NORMAL FLOWS DOMINATED THE AREA. NEW MONTHLY MEAN HIGHS WERE RECORDED IN KENTUCKY, NORTH CAROLINA, AND WEST VIRGINIA. THE MISSISSIPPI RIVER NEAR VICKSBURG, MISS., THE LARGEST DRAINAGE AREA IN THE COUNTRY, HAD THE MAXIMUM DECEMBER MONTHLY MEAN DISCHARGE SINCE 1928 (SEE TABLE OF LARGE RIVERS).

In Virginia, as in all the States in the region with the exception of southern Georgia and adjacent Florida Peninsula, streamflow was above the normal for the month. Flash flooding was reported in some localities, particularly in the counties of Washington, Smyth, and Scott where schools were closed December 11. In eastern and central Virginia, where streamflow decreased; all three index stations had established maximum monthly mean discharges for November and two of the stations also had record-high October flows. Nottoway River near Stony Creek was one of the two (see graph).



Monthly mean discharge of Nottoway River near Stony Creek, Va. (Drainage area, 579 square miles.)

Above-normal flows continued in Kentucky for the third consecutive month. In the northeastern part of the State, Licking River at Catawba (drainage area, 3,300 square miles) had a December monthly mean of 14,220 cfs, the highest in 46 years of record. The Ohio River at Louisville (see table of Large Rivers) recorded the highest December mean discharge since 1928.

In West Virginia, a new monthly December maximum of 12,487 cfs was reported on the Potomac River at Paw Paw (drainage area, 3,109 square miles). This was almost double the November mean, which was the highest since records began in 1938, and exceeded the maximum monthly discharge of any other month with the exception of March.

General rains over North Carolina, December 14–17 and 21–24, produced significant rises in streamflow. Flooding of low bottomlands occurred on the December 16–17 rise. In Mecklenburg County, several secondary-road bridges were inundated for a short period. The southern Piedmont area had high stream stages as a result of 3–4 inches of rainfall in a 24-hour period. Flood-watch warnings were issued for both periods. In the eastern part of the State, Neuse River near Clayton (drainage area, 1,140 square miles) had a monthly mean discharge of 3,760 cfs, the highest December flow since records began in 1927. In central North Carolina, the South Yadkin River near Mocksville (drainage area, 313 square miles) had a monthly mean of 731 cfs, the second highest for December in the 42 years of record.

Runoff was above the normal range at all index stations in Tennessee for the third consecutive month. Flooding occurred on small basins in nearly all portions of the State during the period December 10–12, but operation of flood-control reservoirs prevented serious flooding on the larger streams. Low-lying areas in the City of Knoxville were flooded to the extent that several families were temporarily evacuated, and some businesses suffered considerable flood damage. Most of the flooding in the western part of the State was over farmland, and hundreds of acres were inundated in some counties.

In Florida, streamflow generally increased into the normal range over the peninsular part of the State. Peace River at Arcadia had been below the normal range for the past 5 months.

The flow at Silver Springs, in north-central Florida, decreased 13 cfs, to 687 cfs; 82 percent of normal. Flow southward through the Tamiami Canal outlets, 40-mile bend to Monroe, decreased 17 cfs, to 31 cfs; 45 percent of normal. The flow of Miami Canal at Miami decreased 145 cfs, to 100 cfs; 31 percent of normal.

Ground-water levels generally rose throughout the area; however, they fell at Savannah, Ga., and in the Coastal Plain area of northeastern North Carolina. Monthend levels were generally above average, but were below average in Florida, in the Savannah, Ga., area, and in the heavily pumped area at Memphis, Tenn. In the latter area, a new December low was established for the "500-foot" sand aquifer. In the Piedmont area from North Carolina to Georgia, water levels rose due to the heavy rainfall which occurred throughout the Southeast.

In North Carolina, levels rose for the first time in 5 months in the mountainous area and Piedmont; declines took place in the eastern Coastal Plains of North Carolina, where levels had been inordinately high in November. Monthend levels were well above the long-term average for December in the State.

In Georgia, water levels rose or were about the same as the November levels; however, they were about 2 feet lower than they were a year ago. The heavily pumped Savannah area continued to set new monthly lows.

In West Virginia, ground-water levels rose throughout most of the State. Monthend levels were generally above average in the State, and the monthend level in the

Glenville well, Gilmer County, equaled the record December high established in 1957. Record-high levels were reached at the end of the month in some areas in the southern part of the State; however, monthend levels were slightly below average in parts of four southeastern counties.

In Kentucky, water levels rose due to above-normal precipitation, and an alltime high level was established in the key well near Mayfield, Graves County, Ky.

In Mississippi, small rises occurred in water levels in wells screened in the heavily pumped Sparta Sand in the Jackson area, but water levels in the Sparta aquifer were well below those of a year ago.

In Florida, ground-water levels rose slightly in most areas in the northern and central parts of the State. Index wells in Escambia County (westernmost Panhandle) rose 2.4 feet. Monthend levels were below average in all areas reporting, and ranged from 1.3 feet below average at Orlando (east-central Peninsula) to 7.3 feet below average in Leon County (Tallahassee area), and 9.6 feet below average in Escambia County. In southeastern Florida, levels changed very little during the month, and monthend levels ranged from about average to 1.4 feet below average.

WESTERN GREAT LAKES REGION

[Ontario; Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin]

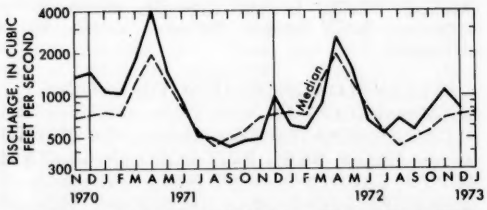
STREAMFLOW DECREASED IN MOST BASINS OF THE REGION, BUT WAS ABOVE THE NORMAL RANGE EXCEPT IN ONTARIO AND IN PARTS OF MICHIGAN, WISCONSIN, AND MINNESOTA.

In east-central Minnesota, the monthly mean discharge of Crow River at Rockford (drainage area, 2,520 square miles) was 453 cfs, almost 10 times the December median, and above the normal range for the 27th consecutive month. Flows of other streams in the State, including Buffalo River near Dilworth, in the west, Mississippi River at St. Paul, in the east, and Minnesota River near Jordan, in the south, also remained above the normal range.

In northwestern Wisconsin, the monthly mean discharge of Jump River at Sheldon (drainage area, 574 square miles) was 193 cfs, 211 percent of the December median, and above the normal range for the fifth consecutive month.

In Illinois and Ohio, streamflow generally decreased, but remained in the above-normal range throughout both States for the fourth consecutive month. The cumulative runoff of Sangamon River at Monticello, in east-central Illinois, during the first quarter of the 1973 water year, was 7 1/2 times the median cumulative runoff for that period.

In the northern part of Michigan's Lower Peninsula, flow of Muskegon River at Evart decreased sharply, as a result of extremely cold weather, and was in the normal range for December (see graph). In southern Michigan,



Monthly mean discharge of Muskegon River at Evart, Mich. (Drainage area, 1,450 square miles.)

monthly mean discharge of Red Cedar River at East Lansing (drainage area, 355 square miles) was 359 cfs, five times the December median, second highest for December since records began in 1930, and in the above-normal range for the fourth consecutive month.

Ground-water levels declined in most of the northern part of the region but generally rose in the southern part. Monthend levels were above average in most of the region but below average in the heavily pumped, artesian aquifers of the Minneapolis-St. Paul, Minn., area, despite a continued, seasonal rise; and were below average in the deep sandstone aquifers in southeastern Wisconsin, where levels continued to decline because of pumpage.

Ground-water levels in shallow, water-table wells in Wisconsin also declined during the month but, in contrast to the levels in the deep sandstone aquifers, were near or above average for December.

Levels in shallow water-table aquifers declined in Minnesota but were above average. The level in the key well at Fort Ripley, Morrison County, in central Minnesota, was the highest for December in 21 years of record.

The water level in the Princeton well, Bureau County, northwestern Illinois (a glacial drift area), reached a new monthly high for December but was below the level for the previous month.

Ground-water levels remained at or near record highs in Indiana and continued their rise from the previous month. A new monthly maximum was set in the Smartsburg well (a sand and gravel aquifer), Montgomery County, for the second consecutive month; a near-record high was reached in the Fountaintown well (Devonian limestone aquifer), Shelby County.

In the northern part of Michigan, ground-water levels generally declined but remained above average. In the southern part of the State, levels rose and some record highs were established.

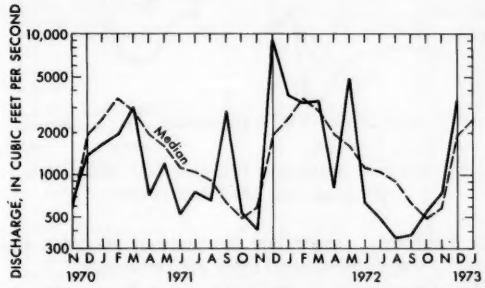
Ground-water levels were generally above average in Ohio, and a key well (Strasburg well, Tuscarawas County, in Pleistocene gravel) in the northeastern part of the State showed a record high.

MIDCONTINENT

[Manitoba and Saskatchewan; Arkansas, Iowa, Kansas, Louisiana, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas]

STREAMFLOW INCREASED IN LOUISIANA, SOUTHEASTERN ARKANSAS, AND EAST-CENTRAL TEXAS, BUT DECREASED ELSEWHERE IN THE REGION. ABOVE-NORMAL STREAMFLOW CONTINUED IN NORTH DAKOTA, IOWA, AND ARKANSAS, AND IN PARTS OF SOUTH DAKOTA AND KANSAS. SOME STREAMS IN SOUTH-WESTERN OKLAHOMA WERE DRY AT MONTHEND BECAUSE OF DROUGHT CONDITIONS,

In Louisiana, streamflow increased into the above-normal range throughout most of the State as a result of persistent, general rains. Monthly mean discharge of Amite River near Denham Springs was 3,350 cfs, 175 percent of median, and above the normal range for December (see graph).



Monthly mean discharge of Amite River near Denham Springs, La. (Drainage area, 1,280 square miles.)

In North Dakota, high carryover flows from November contributed to record-breaking maximum monthly mean and maximum daily mean discharge for December of 52.3 cfs and 60 cfs, respectively, in Cannonball River basin at Breien, where records began in 1934. The maximum daily mean discharge of 60 cfs occurred on several days during the month.

High carryover flows also contributed to the continued above-normal flow in Big Sioux River basin of eastern South Dakota and the adjacent areas of southwestern Minnesota and northwestern Iowa. In the basins of Cedar River, Winnebago River, and Nishnabotna River in Iowa, high carryover flows, augmented by above-normal precipitation, contributed to monthly mean discharges that were 379, 431, and 950 percent of median for December, respectively.

In the Little Blue River basin in southeastern Nebraska and northeastern Kansas, above-normal flow during December was the result of high carryover flow from November plus runoff from melting snow and ice during the latter half of the month.

In south-central Oklahoma, flow at the index station on Washita River near Durwood decreased from the above-normal range in November to the normal range for December. Streamflow in western Oklahoma is below normal and many streams in the southwestern part of the State were dry at monthend. Contents of Lake Altus, in the southwest, remained at 9 percent of normal maximum for the fourth consecutive month. This reservoir is used for flood control, irrigation, municipal water supply, and recreation.

The level of Lake Winnipeg at Gimli, Manitoba, averaged 713.82 feet above mean sea level, 0.80 foot above the long-term mean for the month.

Ground-water levels generally rose in the region; however, there were numerous scattered areas in which declines took place. Monthend levels were above average in the northern part of the region; but from central Nebraska to the Gulf, monthend levels were generally below average.

In North Dakota, levels showed seasonal declines but remained above normal. Water-level in the well at Dickinson, Stark County, N.D., reached a new monthly high.

In Nebraska, water levels in wells rose and were above normal except in areas of heavy pumping for irrigation and public supplies, where residual declines were still present.

In Iowa, water levels in shallow water-table wells declined and ranged from slightly above average to well above average.

In Kansas, ground-water levels generally rose moderately due to above-average precipitation and reduction in pumping.

In Arkansas, the water level in the shallow aquifer (Quaternary deposits) near Stuttgart, east-central Arkansas, where rice is irrigated by wells, rose slightly and was in the same range of December values that it has been since 1965; the water level in the deep aquifer (Sparta Sand) rose seasonally, but was at a new low for December. In the industrial area of central and south Arkansas, water level in the key well in the Sparta Sand at Pine Bluff rose appreciably but established a new December low which differed little from the 1970 and 1971 December lows; at El Dorado, the water level in the key well rose 3 1/2 feet, was 6 feet above the December average, and 28 feet above the December 1966 level.

In Texas, ground-water levels in key observation wells were above average in the Edwards Limestone at Austin and San Antonio; but below average in the Evangeline aquifer at Houston, and in the bolson deposits at El Paso. Water levels rose at San Antonio and Houston, but declined at Austin and El Paso. New December lows were established at Houston and El Paso.

In Louisiana, water levels in the Chicot aquifer in the southwestern part of the State were nearly 31 feet higher than in June when ground water was heavily pumped for rice irrigation. The rise is expected to continue until the beginning of the next irrigation season in late February. In contrast to the general rise in water levels throughout the State, levels in the terrace aquifer of central Louisiana declined slightly.

WEST

[Alberta and British Columbia; Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming]

STREAMFLOW INCREASED IN WASHINGTON, OREGON, AND CALIFORNIA, AND IN PARTS OF ARIZONA AND BRITISH COLUMBIA, AND DECREASED ELSEWHERE IN THE REGION. TWO MAJOR AREAS OF ABOVE-NORMAL FLOW PERSISTED IN THE CENTRAL AND SOUTH-CENTRAL SECTIONS.

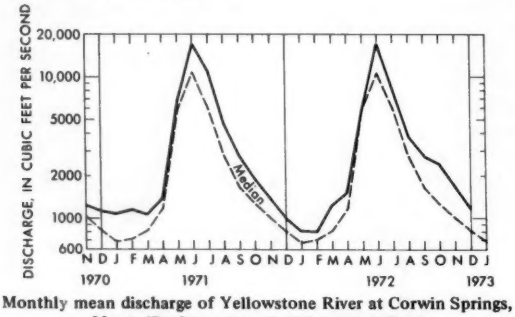
In Washington, Oregon, and California, streamflow increased at all index stations and was roughly three times that of November. The most marked increases were on Chehalis River near Grand Mound, in western Washington, and Smith River near Crescent City, in northwestern California, where monthly mean flows in December were about five times those during November. In northern Washington, monthly mean flow of Skykomish River near Gold Bar was almost triple that of November, and was above the normal range. Flow of Columbia River at The Dalles remained above the normal range for the eighth consecutive month.

In southeastern Idaho, monthly mean discharge of Snake River near Heise remained above the normal range where it has been during 24 of the past 26 months. Large releases from Snake River reservoirs downstream from Heise and upstream from Weiser resulted in a monthly mean discharge of 22,290 cfs at the gaging station at Weiser, third highest for December in 63 years of record. Record-breaking low temperatures during the period December 4-15 caused record high stages from ice jams along Snake River between Ontario, Oreg., and Weiser, in western Idaho, and along a 20-mile reach of Snake River near Blackfoot, and in a long reach of Salmon River near Salmon, in eastern Idaho. The high stages closed roads and flooded several commercial buildings, many residences, and some farm land.

In northern Utah, streamflow decreased seasonally, but remained above the normal range where it has been since September 1972. Level of Great Salt Lake rose 0.30 foot during the month (to 4,198.75 feet above mean sea level) and was 0.85 foot higher than one year ago.

On the western slope of the Continental Divide in Colorado, streamflow generally remained above the normal range for the fourth consecutive month.

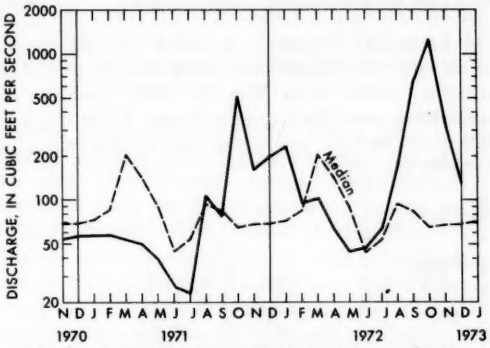
In southern Montana, flow of Yellowstone River at Corwin Springs decreased seasonally, but because of high carryover flow from November and heavy rains during the first week of December, remained in the above-normal range (see graph).



Monthly mean discharge of Yellowstone River at Corwin Springs, Mont. (Drainage area, 2,623 square miles.)

Streamflow in Arizona remained above the normal range for the third consecutive month, except in the northwestern and southeastern corners of the State.

In New Mexico, streamflow decreased at all index stations, but remained above the normal range in the southwest, where monthly mean discharge of Gila River near Gila was 186 percent of the December median and in the above-normal range for the fifth consecutive month (see graph).



Monthly mean discharge of Gila River near Gila, N. Mex. (Drainage area, 1,864 square miles.)

In California, streamflow increased at all index stations but was in the normal range for December.

Reservoir storage in the region generally was near or above average for December in the major reservoirs. Net decrease in storage in the Colorado River Storage Project was 603,200 acre-feet.

Water levels generally showed seasonal rises in the region, but declines took place in many areas in which there was heavy pumping. Monthend levels were above average in the northern part of the region and below average in the southern part; here again, notable exceptions occurred.

In Washington, ground-water levels in the western part of the State rose during the month but were generally below average and below the levels of last December. In eastern Washington, levels generally rose and were above average, but below last year's December levels.

In Idaho, the water level in the key well penetrating sand and gravel in the Boise Valley was above average. Little change occurred in water levels in wells penetrating the Snake Plain aquifer.

In Montana, water levels declined but were generally above average and higher than those recorded in December 1971.

In Utah, water levels generally rose except in the northern part of the State. Levels were below average except for the southeastern part, where they continued above average.

In Nevada, water levels rose and were above average in the east-central and northern key wells; but they fell and established new December lows at Las Vegas and Truckee Meadows in southern and west-central Nevada, respectively. The declines were caused by heavy pumping in the areas.

Provisional data; subject to revision

USABLE CONTENTS OF SELECTED RESERVOIRS NEAR END OF DECEMBER 1972

[Contents are expressed in percent of reservoir capacity. The usable storage capacity of each reservoir is shown in the column headed "Normal maximum."]

Reservoir Principal uses: F–Flood control I–Irrigation M–Municipal P–Power R–Recreation W–Industrial	End of Nov. 1972	End of Dec. 1972	End of Dec. 1971	Average for end of Dec.	Normal maximum
	Percent of normal maximum				
NORTHEAST REGION					
NOVA SCOTIA					
Rossignol, Mulgrave, Falls Lake, St. Margaret's Bay, Black, and Ponhook Reservoirs (P)	52	68	39	47	223,400 (a)
QUEBEC					
Gouin (P)	66	64	49	67	6,487,000 ac-ft
Allard (P)	94	95	58	53	280,600 ac-ft
MAINE					
Seven reservoir systems (MP)	62	63	32	54	179,300 mcf
NEW HAMPSHIRE					
Lake Winnipesaukee (PR)	84	78	59	58	7,200 mcf
Lake Francis (FPR)	82	75	47	68	4,326 mcf
First Connecticut Lake (P)	86	71	32	60	3,330 mcf
VERMONT					
Somerset (P)	73	75	71	65	2,500 mcf
Harriman (P)	77	63	55	59	5,060 mcf
MASSACHUSETTS					
Cobble Mountain and Borden Brook (MP)	76	78	82	72	3,394 mcf
NEW YORK					
Great Sacandaga Lake (FPR)	72	67	61	52	34,270 mcf
Indian Lake (FMP)	85	69	59	59	4,500 mcf
New York City reservoir system (MW)	81	96	82	.....	547,500 mg
NEW JERSEY					
Wanaque (M)	89	101	97	70	27,730 mg
PENNSYLVANIA					
Wallenpaupack (P)	75	75	76	52	6,875 mcf
Pymatuning (FMR)	91	88	82	79	8,191 mcf
MARYLAND					
Baltimore municipal system (M)	100	101	100	81	85,340 mg
SOUTHEAST REGION					
NORTH CAROLINA					
Bridgewater (Lake James) (P)	77	87	80	74	12,580 mcf
High Rock Lake (P)	65	94	67	62	10,230 mcf
Narrows (Badin Lake) (P)	91	100	94	94	5,616 mcf
SOUTH CAROLINA					
Lake Murray (P)	78	81	79	55	70,300 mcf
Lakes Marion and Moultrie (P)	77	89	82	56	81,100 mcf
SOUTH CAROLINA–GEORGIA					
Clark Hill (FP)	52	66	60	48	75,360 mcf
GEORGIA					
Burton (PR)	72	80	74	47	104,000 ac-ft
Lake Sidney Lanier (FMPR)	41	51	57	48	1,686,000 ac-ft
Sinclair (MPR)	58	97	76	68	214,000 ac-ft
ALABAMA					
Lake Martin (P)	63	77	71	56	1,373,000 ac-ft
TENNESSEE VALLEY					
Clinch Projects: Norris and Melton Hill Lakes (FPR)	43	44	33	24	1,166,000 cfsd
Holston Projects: South Holston, Watauga, Boone, Fort Patrick Henry, and Cherokee Lakes (FPR)	54	54	42	26	1,452,000 cfsd
Douglas Lake (FPR)	23	19	13	8	715,800 cfsd
Hiwassee Projects: Chatuge, Nottely, Hiwassee, Apalachia, Blue Ridge, Ocoee 3, and Parksville Lakes (FPR)	50	48	51	34	523,700 cfsd
Little Tennessee Projects: Nantahala, Thorpe, Fontana, and Chilhowee Lakes (FPR)	58	60	46	33	751,400 cfsd
WESTERN GREAT LAKES REGION					
WISCONSIN					
Chippewa and Flambeau (PR)	94	77	78	59	15,900 mcf
Wisconsin River (21 reservoirs) (PR)	88	71	72	51	17,400 mcf
MINNESOTA					
Mississippi River headwater system (FMR)	29	22	28	23	1,640,000 ac-ft

Reservoir Principal uses: F–Flood control I–Irrigation M–Municipal P–Power R–Recreation W–Industrial	End of Nov. 1972	End of Dec. 1972	End of Dec. 1971	Average for end of Dec.	Normal maximum
	Percent of normal maximum				
MIDCONTINENT REGION					
NORTH DAKOTA					
Lake Sakakawea (Garrison) (FIPR)	95	92	90	.....	22,640,000 ac-ft
NEBRASKA					
Lake McConaughy (IP)	78	80	89	69	1,948,000 ac-ft
OKLAHOMA					
Keystone (FPR)	95	95	141	93	661,000 ac-ft
Lake O' The Cherokees (FPR)	102	94	97	76	1,492,000 ac-ft
Tenkiller Ferry (FPR)	106	103	105	86	628,200 ac-ft
Lake Altus (FIMR)	9	9	20	48	134,500 ac-ft
Eufaula (FPR)	106	97	94	76	2,378,000 ac-ft
OKLAHOMA–TEXAS					
Lake Texoma (FMPRW)	99	96	102	89	2,722,000 ac-ft
TEXAS					
Possum Kingdom (IMPRW)	95	91	96	78	724,500 ac-ft
Buchanan (IMPW)	79	77	97	75	955,200 ac-ft
Bridgeport (IMW)	57	54	62	59	270,900 ac-ft
Eagle Mountain (IMW)	91	90	98	86	182,700 ac-ft
Medina Lake (I)	96	95	100	46	254,000 ac-ft
Lake Travis (FIMPRW)	91	93	94	76	1,144,000 ac-ft
Lake Kemp (IMW)	42	42	28	53	461,800 ac-ft
THE WEST					
ALBERTA					
Spray (P)	75	68	58	56	210,000 ac-ft
Lake Minnewanka (P)	90	80	64	64	199,700 ac-ft
St. Mary (I)	69	70	72	61	320,800 ac-ft
WASHINGTON					
Franklin D. Roosevelt Lake (IP)	96	98	95	89	5,232,000 ac-ft
Lake Chelan (PR)	65	51	43	55	676,100 ac-ft
IDAHO–WYOMING					
Upper Snake River (7 reservoirs) (IMP)	73	73	76	62	4,282,000 ac-ft
WYOMING					
Pathfinder, Seminoe, Alcova, Kortes, and Glendo Reservoirs (I)	62	63	70	33	3,016,000 ac-ft
Buffalo Bill (IP)	80	75	71	68	421,300 ac-ft
Boysen (FIP)	80	73	87	73	802,000 ac-ft
Keyhole (F)	84	83	78	32	199,900 ac-ft
COLORADO					
John Martin (FIR)	1	2	3	16	364,400 ac-ft
Colorado–Big Thompson project (I)	72	72	75	53	722,600 ac-ft
Taylor Park (IR)	33	35	61	54	106,000 ac-ft
COLORADO RIVER STORAGE PROJECT					
Lake Powell; Flaming Gorge, Navajo, and Blue Mesa Reservoirs (IFPR)	57	55	55	.....	31,276,500 ac-ft
UTAH–IDAHO					
Bear Lake (IPR)	83	80	79	54	1,421,000 ac-ft
CALIFORNIA					
Hetch Hetchy (MP)	39	34	37	35	360,400 ac-ft
Lake Almanor (P)	72	67	67	42	1,036,000 ac-ft
Shasta Lake (FIPR)	75	76	73	67	4,377,000 ac-ft
Millerton Lake (FI)	47	62	49	52	503,200 ac-ft
Pine Flat (FI)	28	32	42	44	1,014,000 ac-ft
Isabella (FIR)	9	10	22	22	551,800 ac-ft
Folsom (FIP)	60	64	60	50	1,000,000 ac-ft
Lake Berryessa (FIMW)	73	74	85	77	1,600,000 ac-ft
Clair Engle Lake (Lewiston) (P)	75	78	79	75	2,438,000 ac-ft
CALIFORNIA–NEVADA					
Lake Tahoe (IPR)	59	62	72	48	744,600 ac-ft
NEVADA					
Rye Patch (I)	79	79	91	42	179,100 ac-ft
ARIZONA–NEVADA					
Lake Mead and Lake Mohave (FIMP)	70	72	69	65	27,970,000 ac-ft
ARIZONA					
San Carlos (IP)	37	38	13	13	948,600 ac-ft
Salt and Verde River system (IMPR)	62	73	49	34	2,073,000 ac-ft
NEW MEXICO					
Conchas (FIR)	61	61	44	77	352,600 ac-ft
Elephant Butte and Caballo (FIPR)	13	14	7	27	2,539,000 ac-ft

[a] Thousands of kilowatt-hours.

FLOW OF LARGE RIVERS DURING DECEMBER 1972

WRD station number	Stream and place of determination	Drainage area (square miles)	Mean annual discharge through September 1970 (cfs)	December 1972					
				Monthly discharge (cfs)	Percent of median monthly discharge[1]	Change in discharge from previous month (percent)	Discharge near end of month		
							(cfs)	(mgd)	Date
1–0140	St. John River below Fish River at Fort Kent, Maine.	5,690	9,397	4,992	113	-44	4,100	2,650	31
1–3580	Hudson River at Green Island, N.Y.	8,090	12,520	27,500	227	+6	----	----	----
1–4635	Delaware River at Trenton, N.J	6,780	11,360	25,026	233	+2	23,200	15,000	28
1–5705	Susquehanna River at Harrisburg, Pa.	24,100	33,670	96,700	332	+92	75,600	48,860	31
1–6465	Potomac River near Washington, D.C.	11,560	[2]10,640	35,900	444	+85	17,200	11,100	31
2–1055	Cape Fear River at William O. Huske Lock near Tarheel, N.C.	4,810	4,847	14,300	389	+68	8,000	5,170	31
2–1310	Pee Dee River at Peedee, S.C	8,830	9,098	20,300	295	+181	36,100	23,300	29
2–2260	Altamaha River at Doctortown, Ga.	13,600	13,380	9,491	131	+181	13,000	8,400	25
2–3205	Suwannee River at Branford, Fla	7,740	6,775	3,020	88	+19	3,060	1,980	29
2–3580	Apalachicola River at Chattahoochee, Fla.	17,200	21,690	34,200	211	+226	42,500	27,500	29
2–4670	Tombigbee River at Demopolis lock and dam near Coatopa, Ala.	15,400	21,700	37,820	209	+362	46,800	30,200	27
2–4895	Pearl River near Bogalusa, La	6,630	8,533	14,800	357	+385	17,000	11,000	31
3–0495	Allegheny River at Natrona, Pa	11,410	[2]18,700	45,970	238	+62	57,900	37,400	26
3–0850	Monongahela River at Braddock, Pa.	7,337	[2]11,950	41,110	286	+92	37,400	24,200	26
3–1930	Kanawha River at Kanawha Falls, W.Va.	8,367	12,370	29,040	222	+31	23,800	15,400	26
3–2345	Scioto River at Higby, Ohio	5,131	4,337	12,500	768	-19	10,200	6,590	26
3–2945	Ohio River at Louisville, Ky[3]	91,170	110,600	332,700	375	+79	353,700	228,600	26
3–3775	Wabash River at Mount Carmel, Ill.	28,600	26,310	54,160	361	-4	51,000	33,000	29
3–4690	French Broad River below Douglas Dam, Tenn.	4,543	[2]6,528	13,750	271	+102	----	----	----
4–0845	Fox River at Rapide Croche Dam, near Wrightstown, Wis.[3]	6,150	4,142	2,900	88	-62	----	----	----
4–2643.31	St. Lawrence River at Cornwall, Ontario–near Massena, N.Y.[4]	299,000	239,100	269,700	118	-8	260,000	168,000	31
5–0825	Red River of the North at Grand Forks N. Dak.	30,100	2,439	1,308	152	-4	1,250	808	31
5–3300	Minnesota River near Jordan, Minn ..	16,200	3,306	1,670	256	-57	1,400	905	26
5–3310	Mississippi River at St. Paul, Minn ...	36,800	[2]10,230	8,300	170	-49	8,640	5,580	28
5–3655	Chippewa River at Chippewa Falls, Wis.	5,600	5,062	4,026	143	-56	4,880	3,150	27
5–4070	Wisconsin River at Muscoda, Wis	10,300	8,457	9,610	169	-31	----	----	----
5–4465	Rock River near Joslin, Ill	9,520	5,288	----	----	----	----	----	----
5–4745	Mississippi River at Keokuk, Iowa ...	119,000	61,210	50,151	147	-56	61,000	39,400	29
5–4905	Des Moines River at Keosauqua, Iowa.	14,038	5,220	6,284	497	-55	6,200	4,010	29
6–2145	Yellowstone River at Billings, Mont.	11,795	6,754	3,292	111	-32	----	----	----
6–9345	Missouri River at Hermann, Mo	528,200	78,480	63,850	213	-52	57,800	37,400	27
7–2890	Mississippi River near Vicksburg, Miss.[5]	1,144,500	552,700	1,056,000	289	+28	1,245,000	805,000	29
9–3150	Green River at Green River, Utah ...	40,600	6,369	2,183	106	-42	5,000	3,230	31
9–4025	Colorado River near Grand Canyon, Ariz.	137,800	.....	16,500	----	+39	----	----	----
11–4255	Sacramento River at Verona, Calif ...	21,257	18,370	24,030	118	+15	25,100	16,200	29
13–2690	Snake River at Weiser, Idaho	69,200	17,670	22,290	150	+2	26,900	17,400	27
13–3170	Salmon River at White Bird, Idaho ..	13,550	11,060	4,736	109	-6	6,490	4,190	25
13–3425	Clearwater River at Spalding, Idaho ..	9,570	15,320	7,900	119	+54	9,250	5,980	27
14–1057	Columbia River at The Dalles, Oreg.[6]	237,000	194,000	159,200	141	+27	----	----	----
14–1910	Willamette River at Salem, Oreg	7,280	23,370	33,000	76	+106	78,000	50,400	31
15–5155	Tanana River at Nenana, Alaska	27,500	24,040	5,890	95	-11	5,800	3,750	31
	Fraser River at Hope, British Columbia.	78,300	95,300	37,100	86	-31	45,400	29,300	28

[1] Reference period 1931–60 or 1941–70.
[2] Adjusted.
[3] Record furnished by Corps of Engineers.
[4] Record furnished by Buffalo district, Corps of Engineers, through International St. Lawrence River Board of Control. Discharges shown are considered to be the same as discharge at Ogdensburg, N.Y. when adjusted for storage in Lake St. Lawrence.
[5] Records of daily discharge computed jointly by Corps of Engineers and Geological Survey.
[6] Discharge determined from information furnished by Bureau of Reclamation, Corps of Engineers, and Geological Survey.

In New Mexico, ground-water levels remained below average, but generally higher than last month. A new monthly low was established in the key well in the shallow, water-table aquifer in the southern part of the Roswell basin.

In Arizona, water levels fell in some observation wells but rose in most wells during the month. Changes in water levels from last month ranged from -1.54 to +5.26 feet. New December lows for the period of record were measured at the Sahuarita, Elfrida, Avra Valley, and Willcox wells. A new December high was measured at the Safford Valley well.

In California, ground-water levels remained near average in the southern part of the State, with some key wells showing rises and others declines. Monthend levels also varied from above average to below average, depending upon the intensity of local pumping.

ALASKA

Streamflow decreased throughout the State but remained above the normal range in Little Susitna River basin, in south-central Alaska, for the fourth consecutive month, and in Chena River basin, in the central part of the State, for the third consecutive month. The monthly mean discharge of 683 cfs, and the daily mean discharge of 780 cfs, on December 1, were the highest monthly and daily means for December, on Chena River at Fairbanks, since records began at that gaging station in 1949. Elsewhere in the State, streamflow was in the normal range.

HAWAII

Streamflow decreased and was below the normal range for December at all index stations in the State. The monthly mean discharge of 1.04 cfs, and the daily mean of 0.43 cfs on December 11 and 12, were the lowest in the 59 years of record on Kalihi Stream near Honolulu (drainage area, 2.61 square miles). This is the sixth consecutive month of below-normal flow at this gaging station.

WATER RESOURCES REVIEW **DECEMBER 1972**

Cover map shows generalized pattern of streamflow for December based on 22 index stream-gaging stations in Canada and 130 index stations in the United States. Alaska and Hawaii inset maps show streamflow only at the index gaging stations which are located near the points shown by the arrows.

Streamflow for December 1972 is compared with flow for December in the 30-year reference period 1931–60 or 1941–70. Streamflow is considered to be *below normal* if it is within the range of the low flows that have occurred 25 percent of the time (below the lower quartile) during the reference period. Flow for December is considered to be *above normal* if it is within the range of the high flows that have occurred 25 percent of the time (above the upper quartile).

Flow higher than the lower quartile but lower than the upper quartile is described as being within the *normal range.* In the Water Resources Review *normal flow* is defined as the median of the 30 flows of December during the reference period. The normal (median) has been obtained by ranking those 30 flows in their order of magnitude; the highest flow is number 1, the lowest flow is number 30, and the average of the 15th and 16th highest flows is the normal (median).

The normal is an average (but not an arithmetic average) or middle value; half of the time you would expect the December flows to be below the median and half of the time to be above the median. Shorter reference periods are used for the Alaska index stations because of the limited records available.

Statements about *ground-water levels* refer to conditions near the end of December. Water level in each key observation well is compared with average level for the end of December determined from the entire past record for that well or from a 20-year reference period, 1951–70. *Changes in ground-water levels,* unless described otherwise, are from the end of November to the end of December.

The Water Resources Review is published monthly. Special-purpose and summary issues are also published. In the United States, issues of the Review are free on application to the Water Resources Review, U.S. Geological Survey, Washington, D.C. 20242.

This issue was prepared by J.C. Kammerer, H.D. Brice, E.W. Coffay, C.R. Murray, and L.C. Fleshmon from reports of the field offices, January 10, 1973.

AVAILABILITY OF WATER IN KALAMAZOO COUNTY, SOUTHWESTERN MICHIGAN

The accompanying abstract (abridged) and map are from the report, *Availability of water in Kalamazoo County, southwestern Michigan*, by W.B. Allen, J.B. Miller, and W.W. Wood: U.S. Geological Survey Water-Supply Paper 1973, 129 p., 9 pls., 36 figs., 1972; prepared in cooperation with Kalamazoo County and the State of Michigan. Water-Supply Paper 1973 may be purchased for $6.25 from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

ABSTRACT

Kalamazoo County includes parts of the Kalamazoo, St. Joseph, and Paw Paw River basins, which drain into Lake Michigan (fig. 1). Glacial deposits, containing sand and gravel, form an upper and a lower aquifer underlying large parts of the county. Areas of high transmissivity and thick saturated deposits are sufficiently localized to be considered as separate ground-water reservoirs.

Hydrograph separation shows that ground-water runoff composed 65 and 73 percent of the discharge of Kalamazoo River at Comstock and 75 and 79 percent of the discharge of Portage River near Vicksburg in 1965 and 1966, respectively. Based on the hydrologic budgets for the same years, ground-water recharge was 9.1 and 9.0 inches in the Kalamazoo River basin and 12.2 and 11.6 inches in the St. Joseph River basin.

Augusta Creek, Portage Creek near Kalamazoo, and Gourdneck Creek have high, dependable annual runoffs. Spring Brook also is maintained by large ground-water contributions. Storage in these basins could be constructed to provide additional water during low flows for municipal and industrial needs.

Maintaining levels at Crooked and Eagle Lakes has been accomplished by pumping from lower aquifers. Water has been diverted from Gourdneck Creek to maintain levels at West and Austin Lakes. Several relatively undeveloped lakes could be utilized as reservoirs to augment streamflow or to supply water.

Surface and ground water is generally of good chemical quality; however, several streams, including the Kalamazoo River downstream from Kalamazoo, have been degraded by municipal and industrial waste disposal, and in several areas the ground water has been affected by stockpiling of industrial minerals. The water in Barton Lake has been degraded by waste disposal. The ground water is usually very hard and may contain objectionable amounts of iron.

The total surface water available in Kalamazoo County is about 680 mgd, and the dependable supply (7-day Q_2, or average 7-day low flow having a recurrence interval of 2 years) is about 303 mgd. Surface-water withdrawal in 1966 was about 58 mgd, of which 33 mgd was withdrawn from the Kalamazoo River.

The potential withdrawal rates for the ground-water reservoirs, as determined from mathematical models, are estimated to be as follows: Kalamazoo, 39 mgd; Schoolcraft, 17 mgd; Kalamazoo-Portage, 24 mgd; and several small reservoirs, 67 mgd. These total 147 mgd. The values would be increased if aquifers were recharged artificially by surface runoff during winter and spring. The average ground-water withdrawal in the county in 1966 was about 54 mgd. The Kalamazoo River ground-water reservoir furnished about 28 mgd, the Kalamazoo-Portage ground-water reservoir, about 21 mgd, and the other reservoirs, about 5 mgd.

The presence of many inland lakes, streams having high ground-water runoff, and locally undeveloped ground-water reservoirs provides flexibility in water management.

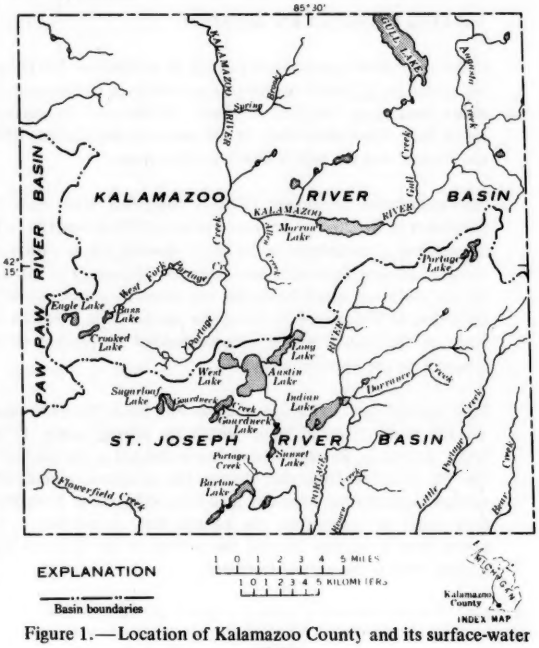


Figure 1.—Location of Kalamazoo County and its surface-water system.

INT: 3430-73

23